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THE SOLUTION OF THE EEL QUESTION

By CARL H. EIGENMANN

WITH FOUR PLATES

Eels are abundant in nearly all the rivers of Europe and the Atlantic slope of the United States. No eels with ripe eggs and no young eels less than three inches long have ever been found in any of these streams. The question naturally arose, How, where, and when do eels reproduce? This, the original eel question, was modified when it became known that the adult eels migrate to the ocean in a sexually immature condition, and young eels enter the mouths of streams and become distributed throughout their length.

The eel question was seriously considered by Aristotle several centuries B. C., and in 1880 A. D. Jacoby wrote, "To a person not acquainted with the circumstances of the case it must seem astonishing, and it certainly is somewhat humiliating to men of science, that a fish which is commoner in many parts of the world than any other fish, the herring perhaps excepted, which is daily seen in the market and on the table, has been able, in spite of the powerful aid of modern science, to shroud the manner of its propagation, its birth, and its death in darkness, which even to the present day has not been completely dispelled."

Many fishes migrate, preliminary to spawning, to regions other than those in which they usually live. It is well known that the salmon of the Pacific slope spend the greater part of their lives in the ocean. When they become sexually mature they run up some stream to deposit their spawn near the head-waters. They may ascend for a thousand miles or more, through rapids and over falls ten feet high and more, to an elevation of many thousand feet.[1] After they enter fresh water they rarely take food. The exhaustion incident to their long journey and the wounds they receive on the spawning beds in cleaning the gravel or in fighting with their rivals prove fatal to all of them. They all die shortly after spawning. The young salmon remain for a variable time where they are born, then descend the streams to the ocean, where they remain till they in turn are sexually mature. The history of the fishes, as long as they are in the streams, can be followed without any great difficulty, but their doings after they enter the less confined regions of salt water are not easy to trace.

The salmon are not the only migratory anadromous fishes. Various other species regularly ascend streams to spawn. Others show a tendency to enter fresh water, or at least brackish water, during the spawning season.[2] Even many fresh-water fishes migrate upstream before the spawning season.

While many species of fishes have the habit of entering fresh water when they approach ripeness, the eel alone has the reverse habit of taking to salt water when the reproductive period approaches. It has been well known for many years that during winter and early spring the young of the eel enter the mouths of streams in enormous numbers. (Redi records the entrance of young eels into the Arno in 1667, and that at Pisa three million pounds of young eels 30–120 mm. were taken in five hours.) They find their way for hundreds of miles from the ocean. "Young individuals three to five inches long ascend rivers in incredible numbers, overcoming all obstacles, ascending vertical walls or flood gates, entering every large and swollen tributary, and making their way even over terra firma to waters shut off from all communications with

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[1] For instance, the elevation of Alturas Lake, one of the spawning grounds of the Chinook and Qinnat Salmon, is 7,335 feet.

[2] During an unusual freshet at San Diego, Cal., in 1889, large numbers of ripe *Cynoscion nobile* ascended the temporary fresh-water streams. Its relative in the Atlantic coast, *Cynoscion regale*, spawns in the brackish water at the mouths of small streams.

rivers."[3] While in the fresh water they feed on everything eatable. When they approach their full size, in about four years, they descend (in autumn) the streams to the ocean, where they are lost sight of beyond a distance of a mile from shore. After these facts were established the eel question became: What do the adult eels do after they enter salt water, when and where do they produce their young, and where do they die?

In how far these questions have been solved and the method of their solution are the topic of the present paper. The solution has been approached along at least three distinct paths.

The search for the reproductive organs.

Three different theories have been held as to the reproduction of the eel. Aristotle supposed that "the eel is neither male nor female and is procreated from nothing; . . . no other animal produces young without eggs, but no eel has ever been found to contain eggs." "They are produced from the so-called 'bowels of the earth' [earthworms] which are spontaneously produced from mud and moist soil." Aristotle contended against another idea prevalent to some extent even in his day—that the eel produces living young—stating that the supposed young eels found in the eel are intestinal worms.

The naturalists of the Middle Ages generally believed that the eel produces living young.

Associated with the idea of Aristotle that eels are spontaneously created through the mediation of earthworms are the notions that the eel is produced by other fishes or even other animals, and in various regions different creatures serve the fisherman as the mother of the eel. A blenny in the north of Germany, a mullet in some parts of the Mediterranean, and a beetle in Sicily, and horse hairs in many parts of the world have been looked upon as the progenitor of the eel.

Interest in the reproduction of the eel has always been kept up. When Schulze died he is said to have expressed the consolation that all the important questions except the eel question had now been settled.

During the sixteenth century, according to Jacoby, the discus-

[3] Mr. Gordon Land, formerly Fish Commissioner of Colorado, told me of the presence of eels in streams of the Los Ojos ranch, Colorado, a distance of about 1,500 miles from the Gulf of Mexico, and at an elevation of about 7,200 feet.

sion of the eel question was limited to the young ones reported to have been found in them. In 1707 Vallisneri published an account of the supposed ovary of an eel sent him by a friend from Comacchio. This eel was distended and contained a body resembling an ovary containing eggs. During the middle of the eighteenth century the fishermen, desirous of gaining the liberal rewards offered for ripe eels, began the perpetration of frauds on the ambitious naturalists, which has continued to our own day. Professor Molinelli received an eel previously stuffed with the eggs of another fish. In 1777 a council of naturalists, containing among others Mondini and Galvani, sat about another apparently ripe eel caught near Comacchio. Mondini reported upon this eel and showed that the structure described by Vallisneri seventy years before as the ovary was only the diseased air bladder, and himself described the true ovary. The ovary was independently discovered by O. F. Müller a few years later.

Spallanzani, after a study of the eel question at Comacchio with purely negative results, rejected the discovery of Mondini, and the latter's observations were not confirmed till 1824, when Rathke independently described the ovary of the eel, and later, in 1850, when the same author described a female with eggs 0.1 mm. in diameter filling the whole abdominal cavity.

After Rathke's description of the ovary of the eel a number of authors took up the hunt for the male reproductive organs. For a time the fatty bodies found in female eels were taken to be the male reproductive glands, and eels were supposed to be hermaphrodite. A new path for research was pointed out when Darwin in his Descent of Man quoted Guenther to the effect that the males of fishes are smaller than the females.

Syrski in 1874 published the first account of the male reproductive gland of the eel. While the discoveries of Mondini, Rathke, and Syrski demonstrated the presence in eels of reproductive organs such as are found in other fishes, we were brought no nearer the solution as to the time and place of reproduction or of the reproductive habits of the eel. A reward was consequently offered by the German Fishery Association for any eels sufficiently well developed sexually to advance the knowledge of the reproductive history of the eel. The only result seems to have been jocose remarks in the funny papers and a continuation of the attempts of the perpetration of frauds on the parts of fishermen.

In 1877 Jacoby visited Comacchio to learn what he could concerning the modifications of eels after they had entered the sea. He found that of eels taken indiscriminately 5 per cent were males, whereas 20 per cent of those less than 45 cm. long were males. He also found that males took part in the fall migration to the sea. He did not succeed in finding eels as much as a mile from shore, and none of those from shallow water near shore showed reproductive organs more advanced than those from fresh water. He concluded that eels must mature in deep water in the ocean and that they die after the spawning season.

Some side lights have been thrown on this part of the eel question by observations on the marine or conger-eel. It has been found that some weeks before it reaches ripeness the conger-eel ceases to eat. The eggs and sperm reach maturity in individuals kept in confinement, but they can not be liberated under the conditions obtaining in confinement and the fish die; in some cases it has happened that the fish burst as the result of the accumulation of ripe eggs which could not be liberated. The feeding habit of the conger-eel thus agrees with that of the Pacific salmon, and it is very probable that the fresh-water eel also stops eating some time before it reaches ripeness. The stomachs of eels migrating to the sea were always found empty by Jacoby.

The conclusions from the series of observations recorded above were that eels have reproductive organs like other fishes, but that they do not reach maturity in fresh water, and that for this reason the difference between the sexes of eels while they are in fresh water are inconspicuous; also that the male eels are, on an average, much smaller than female eels. The inferences were that eels reproduce as other fishes do, and that reproduction takes place in deep water after the period of maturation during which no food is taken.

The discovery of Leptocephali.

While the present phase of the eel question was being approached by the study of the reproductive organs and habits just described, it was being approached from two other directions.

Over two hundred years ago Scopoli (1777) discovered a peculiar, transparent, flat, ribbon-shaped fish with minute head and tail. Others were discovered later, and up to 1895 twenty-five or more species of these fishes, called *Leptocephali,* were described. The extreme transparency of these *Leptocephali* is strikingly shown by *Leptocephalus diptychus* (pl. I, figs. 1, 2), a new one described during the past winter (*Science*, XIII, 828. 1901). This *Leptocephalus* differs from all others in having a series of seven conspicuous black spots along the middle of the sides. On close inspection it was found that three of these spots are on one side and four on the other, that the spots of opposite sides alternate with each other, and that the extreme transparency of the larva results in the blending of the two alternating rows of opposite sides into a single series of spots.

Still other transparent, more cylindrical fishes, slightly more like eels, were described under the name *Helmichthys*. The longest of the *Leptocephali* captured measured 250 mm. They were for a time considered to be a distinct group of fishes. In 1861 Carus studied these forms and came to the conclusion that they are but early stages of other fishes. In 1864 Gill definitely recognized one of the *Leptocephali* (*L. morissii*) as the young of the conger-eel, and the others were supposed to be the larvae of various eels.[4] The question now arose whether the *Leptocephali* were normal stages in the development of eels or "whether they are individuals arrested in their development at a very early period of their life, yet continue to grow to a certain size, without corresponding development of their internal organs, and perishing without having attained the character of the perfect animal." From the fact that the longest young eels were shorter than the longest *Leptocephali* Guenther favored the idea that *Leptocephali* are abnormal larvae. In 1886 Delage (C. Rend., CIII, 690.) published his observations on the actual transformation of a *Leptocephalus* into the conger-eel, and thus demonstrated the fact that the *Leptocephali* are normal larvae.

The discovery of ripe eel eggs.

The third and last path to the present phase of the eel question was discovered by Raffaele. The Italians being most favorably located have done most toward the solution of the eel problems. In 1888 Raffaele described five species of pelagic eggs from the Bay of Naples which, on account of the larvae into which they developed, he referred to various unknown species of eels. He was able to

[4] Other fishes have *Leptocephalus*-like larvae differing from those of the eel largely in the fins and tail. In 1889 Professor Gilbert showed me complete series of stages, from a long slender band-shaped *Leptocephalus* to a much shorter individual of *Albula vulpes*. They were taken by him in a shore seine on the coast of Lower California.

keep them for fourteen to fifteen days only and was therefore unable to determine to what particular species of eels they belonged. The eggs had all the characteristics and habits of pelagic eggs.[5] Grassi later found the same eggs at Naples.

The eggs described by Raffaele have certain characters in common: They are much larger than average sized pelagic eggs; they have a very large perivitelline space; their yolk is vesicular; they differ from each other in size and the presence or absence of an oil sphere. One of the eggs, his No. 10, has a diameter of 2.7 mm. and is without an oil sphere.[6] It develops into a larva with 44 (45) abdominal segments. All of them were taken between August and November, being more abundant in September.

When the larva is five or six days old it is slender and elongated with a greatly compressed body, very transparent, and with little pigment. The vitellus is very elongated and diminishes from in front backwards. The intestine ends in the ventral fin fold a short distance from the body in a small accumulation of cells. The notochord is formed of a single series of segments. During the second day after hatching the mouth opens. The teeth develop rapidly. Three pairs are developed in the upper jaw. This dentition is absolutely exceptional among fishes. Contemporaneously with the development of the mouth the choroidal pigment and five or six black pigmented spots form along the body. No noteworthy changes take place between the fourth and fifth day after hatching. Beyond this time he was unable to rear the eggs.

The identification of the egg and larva of the European eel.

The capping stone for the triple arch constructed by the anatomists, descriptive zoologists, and embryologists respectively was brought by Grassi in 1897. Grassi begins the English abstract of his work as follows: "Four years of continuous researches made by me in collaboration with my pupil, Dr. Colandruccio, have been crowned at last by a success beyond my expectation, that is to say, have enabled me to dispel in the most important points the great mystery which has hitherto surrounded the reproduction and the development of the common eel. . . . The most salient fact discovered by me is that a fish, which hitherto was known as *Leptoceph-*

[5] Raffaele. Le uova galleggianti e le larve dei Teleostei nel golfo di Napoli., *Mith. aus der Zool. Station zu Neapel*, VIII, pp. 1–84, tav. 1–5.

[6] None of the eggs taken from the fresh-water eel exceed 0.27 mm. diameter.

alus brevirostris, is the larva of the *Anguilla vulgaris*." He was able to follow a *Leptocephalus* through its metamorphosis into the common eel. He supposed that normally these processes go on at a depth of at least five hundred meters. His work was carried on on the coast of Sicily, where strong tidal currents cause the displacement of the water in the narrow Strait of Messina. As the result of these currents all stages in the development of the Muraenoids are sometimes met with in the surface water. They are also abundant in the stomach of the sun-fish, Mola.

He found that the male eels may ripen in shallow water and migrate when ripe to deeper water. Some eels approaching ripeness were found in the sewers of Rome. The ripe male eel has taken on a silvery color and its eyes are very much larger than those of the river eels.[7]

The females never ripen in shallow water. The eggs he supposes are laid at a great depth and remain suspended at a great depth, only occasionally reaching the surface. Instead of being small, as had been supposed, they are really much above the average of pelagic eggs in size. From the eggs come prae-larvae which develop into the regular larvae or *Leptocephali* (fig. 4) with the anus and urinary organs near the tip of the tail. The larvae are metamorphosed into what he calls hemilarvae with the two openings moving toward the permanent position. By further changes, which include a considerable reduction in length, the hemilarva assumes the shape of the adult. Both the larva and hemilarva are longer than the young eel arising from them, there being a diminution of 4 cm. in length during the transformation. He found that the caudal fin of the *Leptocephalus* always resembled the caudal fin of the adult eel into which it developed and that the number of segments is also a constant character. He identified Raffaele's egg No. 10, without oil sphere and with a diameter of 2.7 mm., to be that of the common eel.

The discovery of the Leptocephalus of the American eel.

During the past winter while describing the *Leptocephali* belonging to the United States National Museum one of my students, Mr. Clarence Kennedy, and myself discovered two specimens taken on

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[7] Bean in the *Nineteenth Report of the Commission of Fisheries of New York*, p. 289, described five male eels with well-developed reproductive organs which were probably ordinary eels in their nuptial dress. He describes them as having "large eyes, short snout, and long pectoral fins, as compared with the common form, silvery gray above with a clear satiny white abdomen separated from the color above by the lateral line."

the surface of the ocean off New York that in shape, color, etc., very greatly resembled the *Leptocephalus* of the European eel. When we found that the American eel had fewer vertebrae than the European eel, and that the larvae under consideration differed from the larvae of the European eel in just those characters in which the American eel differs from the European, we felt certain that we had found the larva of the American eel (fig. 3).

The development of the conger-eel.

During August of 1900 I was fortunate enough to secure the eggs of an eel, very probably that of the conger-eel. They were taken by Dr. Porter E. Sargent on the U. S. F. C. vessel *Grampus* from the surface of the Gulf Stream. They are the first eel eggs that have been secured outside Italian waters. Since in their development they greatly resemble the development of the fresh-water eel their history may be added.

The eggs secured by Dr. Sargent measure 2.4–2.75 mm. from membrane to membrane. The yolk, as in the eggs described by Raffaele, is made up of transparent spheres not unlike those of the eggs of certain clupeoids. There are present from one to six light yellow oil spheres of variable size. If more than one are present, then one is always much larger than any of the others. The yolk measures 1.75–2 mm. Some of the young were found to be hatched on the morning of August 3. Since many of these developed gaping jaws, and some others, which did not hatch till several days later, developed normally, it is possible that the early hatching was not normal. Raffaele's eggs hatched in five or six days. He was able to keep them four or five days after hatching. For some time after hatching the larvae floated with their heads upward—the probable result of the location of the oil spheres. On August 6 they had assumed a normal horizontal position and the characteristic eel-like progression, but the pectorals were not yet used in swimming. Later they were seen eeling their way through the water, not infrequently nosing about the bottom and voraciously seizing anything that came in their way.

The characteristic feature of the eggs at the time I began to observe them, August 1, was the shape of the yolk. The bulk of this occupied the usual position, but a narrow stalk extended back below the alimentary canal. The oil sphere or spheres occupied the extreme anterior part of the yolk[8] (fig. 5). The further history of the yolk in this species is unique among fishes and not sufficiently emphasized by Raffaele. In fig. 6 it is seen that the yolk is no longer rounded anteriorly, but that it ends in a marked protuberance and that the oil sphere lies in this. The general mass of the yolk still retains the original shape and distribution. The anterior protuberance now becomes longer and at the same time narrower, so that the oil sphere loses its rotundity and becomes elongate (fig. 7). At the same time the general mass of the yolk diminishes rapidly in the yolk sac, while in the elongated pouch along the ventral side of the alimentary canal no diminution is evident. On the contrary, there is an apparent increase; the entire yolk sac becomes notably longer with the increase in the length of the body. Very soon (fig. 7) the oil sphere, much elongated, with a small surrounding mass, is all that remains as a spindle-shaped figure in the yolk sac.

The yolk sac does not at once lose its shape and bulk, but serves as an unusually large pericardial chamber which is equaled only in the practically yolkless *Cymatogaster*. On August 5 the yolk along the alimentary canal had suffered little diminution, and its outlines were quite regular (fig. 8). On August 6 this part of the yolk had become constricted in places, the outlines being less regular (fig. 9). The yolk had become yellowish in color and more fluid than vesicular. On the following day (fig. 10) the constriction had deepened, and on August 11 the remains of the yolk were located in a series of minute globules more or less widely separated from each other (fig. 11). Long before this condition was reached, about the 8th of August, the larvae were taking food.

The number of segments developed in front of the anus differs slightly, ranging from sixty-five to seventy-one. The number beyond this point could not be determined exactly. The notochord consists in its anterior fourth of single segments. In its middle region the segments do not extend through its entire thickness, but in the tail it is again formed of single segments. The lines separating these are so much more conspicuous than the lines separating successive myotomes that it is impossible to make out the latter in the thin transparent tail.

8 All drawings were made from living specimens, or such as had just been killed by formalin. In the drawings, *al*, alimentary canal; *fv*, fourth ventricle; *ylk*, yolk; *l*, liver; *h*, heart; *o*, oil spheres.

Color is late in making its appearance. It is first evident at the end of the tail. At 6:00 P.M. on August 5 some of the larvae had the following six spots above the alimentary canal and along the lower margin of the myotomes of the tail: (1) About the middle of the yolk, (2) halfway between this and the end of the yolk, (3) at the end of the yolk, (4) in front of the anus, (5) some distance behind the anus, (6) about the tip of the tail. Additional spots are added between these already formed. The relative and actual size of the spots differ greatly, but the number is the same in different specimens of the same age. In the oldest larvae the spots represented in fig. 11 were developed. Aside from those along the lower part of the sides there were a few cells on the upper jaw, and the scattered cells seen near the tip of the lower jaw as early as August 7 (fig. 10) have developed into a well-marked spot. The character of the pigment about the tail is also noteworthy. In the last stage figured the processes of the cells show a tendency to lie parallel to the embryonic fin rays. Pigment is formed in the eye with its earliest appearance on the body. No color, aside from the black pigment spots and the yellowish yolk, is seen anywhere about the larva during the time the larvae were under observation.

The fin fold is well developed, reaching from the nape around the tail to the yolk sac. It is much wider along the back and in the region of the vent than about the tip of the tail or the ventral line of anterior abdomen. No rays had appeared in the oldest larvae observed except about the tail, where there appears a distinct radiation.

The enormous development of the posterior half of the fourth ventricle is similar to the condition figured by Raffaele. In all but the last stage figured this part of the fourth ventricle is a large thin-roofed vesicle, separated from the fin fold in the earlier stages by a distinct notch. The auditory capsules are conspicuous, and, viewed from above, are seen to protrude from the sides of the head.

The alimentary canal is marked (1) by large fang-like teeth, (2) the early vesicular development of the liver, (3) and the position of the anus near the body and remote from the margin of the ventral fin fold. As soon as the mouth is open, about the fourth or fifth day from the beginning of development, the margins of the jaws are seen to be marked by small protuberances. These are the swellings within which the teeth are developing. In the upper jaw four pairs of teeth are developed, graded from in front back, the anterior ones being comparatively enormous fangs. In the lower jaw four pairs are also developed. These are more uniform in size, but with the second one larger than the rest. In the oldest individual there were five pairs of teeth in the lower jaw. I am unable to say whether this was a normal condition. The teeth of the upper jaw close over those of the lower jaw (fig. 12).

The oesophageal pouch (liver) of Raffaele has already been mentioned. Even before hatching it is a conspicuous pouch behind the heart. Later, when the anterior yolk has been largely consumed and is separated from the posterior yolk by a constriction, the vesicular structure becomes converted into a lobulated organ about this constriction.

Conclusions.

We now know (1) that eels, both male and female, migrate to the ocean during October to January; (2) that these eels probably deposit the eggs that are found on the surface during the following August to January; (3) that the eels do not ripen in shallow water, but the female, according to Grassi, at a depth of five hundred meters; (4) that the eggs of the eels float, according to Grassi, at a great depth; according to Raffaele and Eigenmann at the surface; (5) the development of some eels for the first fifteen days and that the resulting creature is different both from the adult eel into which it will develop and from the larva of the eel; (6) the *Leptocephalus* of the eel and the process of its metamorphosis through a *Hemichthys* stage into the young eel as it is found entering the streams; (7) the young eels enter the streams during spring about two years after their parents have entered the sea.

We do not know the history of the larva from an age of fifteen days till they reach the *Leptocephalus* stage. We do not know for a certainty that the egg and early stages of development of the common eel has been secured, although it is very probable that Raffaele's No. 10 is the egg of the common European eel. We are not certain that the egg is normally or only occasionally pelagic. We do not know the normal habits of the *Leptocephalus*. We have not yet secured a female eel with eggs larger than 0.27 mm. Inasmuch as the mature egg probably reaches a diameter of 2.7 mm., the largest ovarian eggs found must increase a thousand-fold before maturity is reached.

The question whether or not the eel ever breeds in fresh water has been answered in the affirmative by several observers. There is nothing that would indicate the inherent impossibility of eels becoming land-locked and breeding in fresh water. The evidence is, however, so far inconclusive. No one has yet taken eel eggs or larval eels or younger eels than those that ordinarily ascend streams from the ocean in any fresh water. The statement that they must breed, because we know of no other way in which the supply of eels is being maintained in land-locked basins is not conclusive evidence that they do breed in these basins.

Feddersen[9] states that in the north the eels have in places become strictly fresh-water species which can be distinguished from the migratory eels by definite characters.

Imhof[10] concluded that eels breed in fresh water on the following evidence: In 1882, 1886, and 1887 a large number of eels were placed in the Caumasee (Canton Graubünden). After 1887 no additions were made. In June, 1895, a small male eel 47 cm. long was taken among other eels. From the impossibility that eels should have arrived from the ocean by migration, since the Caumasee belongs to an isolated water-basin, the presence of this small eel was supposed to demonstrate the fact that the eels had propagated in this lake. The evidence does not seem to me to be conclusive. Male eels are much smaller than female eels, whereas nothing is known to the contrary that the time required by the small male to reach its full size is not as great as the time required for the female to reach her full size. If the time required be the same, then the finding of a male eel 47 cm. long is no more evidence of recent breeding in this lake than the presence of female eels 1½ m. long. The question whether or not the eel ever breeds in fresh water may be considered undecided.

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9 "Ueber das Laichen des Aales im Süsswasser," *Zeitschrift f. Fischerei u. deren Hilfswissenschaften*, pp. 156–67. 1895.

10 *Biologisches Centralblatt*, XVI, p. 431. 1896.

EXPLANATION OF PLATES

Plate I

Fig. 1. *Leptocephalus diptychus*, *a* and *b*, enlarged views of the head and tail.

Fig. 2. *Leptocephalus diptychus*, an older larva; *a* and *b*, enlarged views of head and tail.

Fig. 3. *Leptocephalus Grassii*, the larva of the American eel.

Plate II

Fig. 4. The metamorphosis of the European eel after drawings by Grassi.

Figs. 5 to 12 refer to the development of the Conger-eel.

Fig. 5. Outline of embryo showing position in membrane and shape of the yolk. Aug. 1.

Fig. 6. Embryo freed from its membrane, showing the beginning of the constriction of the yolk at its anterior end. Aug. 1.

Plate III

Fig. 7. Head and anterior part of body showing the continued reduction of the yolk and the very large fourth ventricle. Aug. 1.

Fig. 8. A larva on Aug. 5.

Fig. 9. A larva on Aug. 6. The mouth probably slightly abnormal.

Fig. 10. A larva on Aug. 7.

Plate IV

Fig. 11. A larva of Aug. 14. The fin fold of this larva is probably represented as too low.

Fig. 12. Dentition of a larva of Aug. 14.

Fig. 13. The full-grown *Leptocephalus Morissii*, the larva of the Conger-eel; *a* and *b*, enlarged views of the head and tail.

Fig. 14. An older *Leptocephalus Morissii* undergoing its metamorphosis; *a* and *b*, enlarged views of the head and tail.